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Hunting and Hallucinogens: The Use Psychoactive and Other Plants to Improve the Hunting Ability of Dogs

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Abstract

Ethnopharmacological relevance

Cultures throughout the world give plants to their dogs in order to improve hunting success. These practices are best developed in lowland Ecuador and Peru. There is no experimental evidence for the efficacy of these practices nor critical reviews that consider possible pharmacological effects on dogs based on the chemistry of the ethnoverterinary plants.

Aim

This review has three specific aims: 1. Determine what plants the Ecuadorian Shuar and Quichua give to dogs to improve their hunting abilities, 2. Determine what plants other cultures give to dogs for the same purpose, and 3. Assess the possible pharmacological basis for the use of these plants, particularly the psychoactive ones?

Methods

We gathered Shuar (Province of Morona-Santaigo) and Quichua (Napo and Orellano Provinces) data from our previous publications and field notes. All specimens were vouchered and

deposited in QCNE with duplicates sent to NY and MO. Data presented from other cultures derived from published studies on ethnoveterinary medicine. Species names were updated, when necessary, and family assignments follow APG III (Angiosperm Phylogeny Group 2009). Chemical data were found using PubMed and SciFinder.

Results

The Shuar and Quichua of Ecuador use at least 22 species for ethnoveterinary purposes, including all but one of their principal hallucinogens. Literature surveys identified 43 species used in other cultures to improve hunting ability. No published studies have examined the pharmacological active of these plant species in dogs. We, thus, combined phytochemical data with the ethnobotanical reports of each plant and then classified each species into a likely pharmacological category: depuratives/deodorant, olfactory sensitizer, ophthalmic, or psychoactive.

Conclusions

The use of psychoactive substances to improve a dog's hunting ability seems counterintuitive, yet its prevalence suggests that it is both adaptive and that it has an underlying pharmacological explanation. We hypothesize that hallucinogenic plants alter perception in hunting dogs by diminishing extraneous signals and by enhancing sensory perception (most likely olfaction) that is directly involved in the detection and capture of game. If this is true, plant substances also might enhance the ability of dogs to detect explosives, drugs, human remains, or other targets for which they are valued.

Keywords: Ecuador, hallucinogens, hunting, psychoactive plants, Shuar, Quichua

1. Introduction

Dogs (*Canis lupus familiaris*) in the New World originated from multiple Old World lineages that migrated with late Pleistocene humans across the Bering Strait (Leonard et al. 2002). They entered South America with the early human colonists and also were re-introduced by European explorers. Dogs were apparently absent in the Amazon Basin (until the historical period) but present in the Guyanas and the Orinoco River Basin. Following European contact, genetic evidence suggests that newly introduced European dog races began to replace native dogs throughout the Americas (Koster (2009). Hunting dogs are now common throughout much of the Amazon region (Fig. 1).

Fig. 1. Hunting dog in a Quichua village in Ecuador.

The role of dogs in human societies is diverse. They assist in warfare, detect odors, deter pest and predatory animals, guard property and people, guide the blind and deaf, protect other domesticated animals, provide human companionship, pull sleds, rescue lost and injured humans, and track and retrieve game animals. They also provide food and fur, serve as living blankets, and function in symbolic rituals (Diamond 1997, Coppinger and Schneider 1995, Hart 1995). Dogs play an important role in religions and rituals throughout the world. Ecuadorian Shuar believe that dogs are a gift from Nunkui, the earth mother (Bennett et al. 2002). According to the Quichua, dogs are gifts from sachahuarmi or sacharuna (forest spirits). They believe the canines protect hunters and family members from malevolent forest spirits called mal aire (bad air) and mal ojo (evil eye). They also believe that dogs dream and that they have souls (Kohn 2007). The Egyptian god Anbu (or Anubis) is often portrayed as a man with the

head of a dog or jackal (Gadalla 2001). Xolotl, twin of the Aztec god Quetzalcoatl, was the dog god and served as a guide to the dead (Fernández 1992). As part of a burial ritual, Aztec inhabitants of Anahuac killed a dog and laid it beside a human corpse. They believed that four years after death, the dog carried human soul to Chicunauhapan, the ultimate resting place of the dead (Beyer 1908). Dogs possess social-cognitive traits that allow them to communicate with humans in ways unlike any other animal (Hare et al. 2002).

In lowland areas of the Neotropics, the primary role of canines is to assist in hunting wild game. Hunting efficiency using dogs compares favorably to other forms of hunting (Koster 2009). The percentage of hunting trips that included dogs varies widely across cultures from a high of 83% (Mayangna and Miskito of Nicaragua) to 3% (Piro of Peru). Hunting success with dogs depends in large part on the targeted species. Although canines can be employed for any terrestrial species, they are particularly effective against pacas (*Cuniculus paca*, Fig. 2), agoutis (*Dasyprocta* spp.), and other animals that thrive in anthropogenic environments. The absence of dogs among some lowland cultures may be due to high mortality rates of dogs, rather than a canine aversion.

Figure 2. Spotted paca (*Cuniculus paca*) in Ecuador.

Mortality in Neotropical dogs results from the interaction of factors including hunting-induced wounds, malnutrition, microbial pathogens, and parasitic infections. Owing to their importance in hunting, it is not surprising that many cultures have a robust pharmacopoeia especially for dogs (e.g., Bennett et al. 2002; Lans et al. 2000, 2001; Leonard et al. 2002; Jernigan 2009). Nonetheless, ethnoveterinary medicinal research is incipient (Nobrega Alves et

al. 2010). Within many cultures, hunting dogs receive particularly good care (Koster 2009). A Shuar woman, for example, may nurse a pup along with her own children (Bennett et al. 2002). In training dogs, both the Shuar and Quichua maintain the animals with a minimal diet supplemented with wild plants. While many plant species are employed to target canine illnesses, the majority are used to enhance the hunting ability of dogs. In a study that focused exclusively on ethnoveterinary practices, Jernigan (2009) identified 34 plants, that the Peruvian Aguaruna give to their dogs, most often to improve their hunting prowess. Plants are employed in baths to reduce their scent or to mask odors and thus decreasing their detectability by the targeted prey. Plants also function to clean buccal and nasal cavities to enhance olfaction (e.g., Lans et al. 2001, Sanz-Biset et al. 2009) or to enhance night vision (Wilbert 1987).

Neotropical hunters employ magic, rituals, and charms to improve their hunting success and similar methods are used on dogs (Koster 2009, Shephard 2002). Koster (2009) notes the "occasional" use of hallucinogens, but the use psychoactive plants is actually frequent and widespread in many parts of the Old and, especially, the New World tropics (e.g., Bennett et al. 2002). The employment of psychoactive substances to enhance hunting ability seems to be counterintuitive, yet its prevalence suggests that it is both adaptive and that it has an underlying pharmacological explanation. In this paper, we address three questions:

1. What plants do the Ecuadorian Shuar and Quichua give to dogs to improve their hunting abilities?
2. What plants do other cultures give to dogs?
3. What is the likely pharmacological basis for the use of these plants, particularly the psychoactive ones?

The Shuar and Quichua are the largest indigenous groups in lowland Ecuador. They mostly reside at elevations from 300 to 1,200 m in terra firme forests. This territory spans two of Holdridge's (1967) life zones, tropical moist forest and premontane tropical wet forest. Study sites were located in the Provinces of Morona-Santiago and Napo (Fig. 3). Both groups are horticulturists, growing manioc (*Manihot esculenta*) and plantains (*Musa* × *paradisiaca* L.) as their principle starches. Hunting (Fig. 4) and fishing supplement animal sources of protein from domesticated chickens and pigs. More data on the research sites and the two cultures can be found in Bennett et al. (2002) and Bennett and Alarcon (1994).

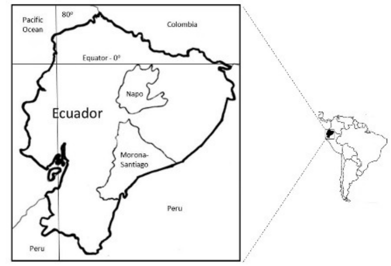

Figure 3. Provinces of Morona-Santiago, where the Shuar, and Napo, where the Quichua ,of this study reside.

Figure 4. Shuar hunter in Yukutais with blowgun.

2. Methods

The Shuar data analyzed here was published in Bennett (1992a, 1992b, 1994) and Bennett et al. (2002). The Quichua data comes from Alarcón (1988), Bennett and Alarcón (1994) and our unpublished field notes. Voucher specimens are deposited in QCNE in Ecuador with duplicates in NY and MO in the U.S. We located data on ethnoveterinary medicine from other tropical cultures from ethnobotanical monographs, JEP publications, and searches using Web of Science and Google Scholar. Family circumscriptions and species names have changed since many of the data sources were first published. Data presented here follows APG III family circumscriptions (Angiosperm Phylogeny Group 2009). Species names follow The Plant List (2015) except as

noted. Author citations are included in the text for species not cited in Tables 1 or 2. Chemical data was found using PubMed and SciFinder.

3. Results

3.1 Shuar and Quichua

The Shuar and Quichua employ at least 22 species for dogs (Table 1). The studies from which these data were drawn did not focus on ethnoveterinary medicines. It is therefore likely that more exist. In most case, the plants have corresponding human uses. However, some species or varieties are especially designated for canines. Four Shuar ethnoveterinary plants carry the name yawá, which means dog in the Shuar language: yawá kunkunari (*Justicia pectoralis*), yawá urints (*Alternanthera paronychioides*), yawá piripiri (*Cyperus* sp.) and yawá maikua (*Brugmansia versicolor*). With the exception of *Brunfelsia grandiflora* D. Don., all the principal Shuar hallucinogens are given to dogs.

Seven of the plants were utilized for purely medical reasons, mostly to treat botfly or other infections. The remaining plants are given to hunting dogs specifically to enhance their hunting prowess. Nine were used for the general purpose of improving hunting ability. A mixture of manioc and akapmas (*Fittonia albivenis*) was said to improve the ability to track game. Kunápik (*Tabernaemontana sananho)* and yawá piripiri (*Cyperus* sp.) appear to initiate hunting predilections in dogs. Quichua give payanshi (*Abuta grandifolia*) to their hunting dogs to keep them quiet and both the Quichua and the Shuar give the potent stimulant wais (*Ilex guayusa,*

Figure 5. *Ilex guayusa* (Aquifoliaceae) leaves known as wais in the Shuar and guayusa in the Runa languages.

Fig. 5) to their hunting dogs so that “they will not be lazy.”

Table 1. Shuar and Quichua plants given to dogs. Source of data: when not specified - Bennett et al. 2002; footnotes indicate other sources. Family names follow APG III (Angiosperm Phylogeny Group 2009). Species names follow The Plant List (2105), except where indicated. SH = Shuar, QU =Quichua, SP=Spanish. For plant parts: BK=bark, FL=flower, FR=fruit, IF=inflorescence, LF=leaf, LX=latex, TU=Tuber.

Species	**Family**	**Voucher**	**Common Name**	**Use**
Fittonia albivenis (Lindl. ex Veitch) Brummitt	Acanthaceae	Bennett 3712	AKAPMAS [SH: derived from akap “liver”]	SH give masticated LF, mixed with *Manihot esculenta* & meat, to improve dogs’ ability to track game
Justicia pectoralis Jacq.	Acanthaceae	Pujupet 1009	YAWÁ KUNKUNARI [SH: yawá "dog" kunkunari unknown]	SH mix LF mixed with food, to improve dogs’ hunting ability
Alternanthera paronychioides A. St.-Hil.	Amaranthaceae	Warush 44	YAWÁ URINTS [SH: yawá "dog" urints known"]	SH give LF to improve dogs’ hunting ability
Tabernaemontana sananho Ruíz & Pav.	Apocynaceae	Bennett 4081	KUNÁPIK [SH: kunápik *Tabernaemontana* sp.]	SH give LX to dogs so that "they won't be vagrants.” BK also given to dogs that “don't hunt.”
Ilex guayusa Loes.	Aquifoliaceae	Bennett 3659	WAIS [SH: waís from QU: guayusa = *Ilex guayusa*]	SH give LF decoction to hunting dogs
Anthurium eminens Schott	Araceae	Bennett 4543	TACOTA SHIPU [QU: toccata unknown shipu “infested with worms”]	QU grind the IN, then apply it to botfly infections in animals[1]
Anthurium gracile (Rudge) Schott[2]	Araceae	Bennett 3705	WANKAT [SH: wankat *Anthurium* or *Philodendron* spp.]	QU apply FR to kill botfly larvae in cattle & dogs[2]
Caladium bicolor (Aiton) Vent.	Araceae	Warush 50	USHU [SH: ushu = *Caladium bicolor*]	SH treat animals infested with worms with LF sap

***Caladium schomburgkii* Schott**	Araceae	Utitiaj 16	APINIU WANCHÚP [SH: napiniu may be from napi "snake" wanchúp perhaps *Xanthosoma* sp.]	SH give plant extract to dogs to improve their hunting ability
Cyperus sp.	Cyperaceae	Warush 23	YAWÁ PIRIPIRI [SH: yawa "dog" piripiri "Cyperaceae spp."]	SH give TU given to dogs or mix with saliva & place in dog's eyes to make them become hunters
Euphorbia hirta L.	Euphorbiaceae	Bennett 4010	LOMO PACHINA [perhaps SP: lomo "back" QU: pachina maybe from papachina=*Colocasia esculenta*]	QU give LX to dogs to make them better hunters[1]
Manihot esculenta Crantz	Euphorbiaceae	Bennett 3320	MAMA [SH: mama = *Manihot esculenta*]	SH give TU mixed with masticated *Fittonia albivenis* LF to dogs so that they can follow animal trails
Desmodium sp.	Fabaceae	Kunkumas 191	MÍIKMAN [SH: derived from míik "bean"]	SH bathe dogs with a LF decocotion.
Casearia aff. *commersoniana* Cambess	Salicaceae	Bennett 4135	YAMAKAI [SH: also refers to *Ryania speciosa* Vahl var. *speciosa*]	SH treat mange with plant
Salvia angulata Benth.	Lamiaceae	Gómez 397	PURGA PERRO [SP: "dog purgative"]	SH use FL & FR decocotion for a variety of ailments. Common names suggests its ethnoveterinary use
Abuta grandifolia (Mart.) Sandwith	Menispermaceae	Bennett 4400	PAYANSHI [QU: payanshi = *Abuta grandifolia*]	QU give BK decoction to dogs before hunting to keep them quiet[1]
Ficus insipida Willd. ssp. *insipida*	Moraceae	Anananch 154	JAPÁ WAMPÚ [SH: japá deer wampúch "light weight"]	SH give LX to dogs, probably as a anthelmintic

Osteophloeum platyspermum (Spruce ex A. DC.) Warb.	Myristicaceae	Palacios 4694	ANYA CASPI (QU: anya "counsel?" huapa "Myristicaceae spp.")	QU give resin to dogs to improve their hunting abilities.[3]
Virola duckei A.C. Sm.	Myristicaceae	Palacios 1780	HUAPA BLANCA (QU: huapa "Myristicaceae spp." SP: blanca "white")	Employed in same manner as *Osteophloeum platyspermum*[3]
Brugmansia suaveolens (Humb. & Bonpl. ex Willd.) Bercht. & C. Presl	Solanaceae	Bennett 3312	MAIKUA [SH: maikua = *Brugmansia* spp.] GUANDU [QU: maikua = *Brugmansia* spp.]	QU & SH give extracts to to dogs to improve their hunting ability.
Brugmansia versicolor Lagerh.	Solanaceae	Shiki 333	YAWÁ MAIKUA [SH: yawá "dog" maikua *Brugmansia* spp.]	SH give 3 crushed LF every 12 hours to make them good hunters
Brugmansia × *insignis* (Barb. Rodr.) Lockwood ex E.W. Davis	Solanaceae	Bennett 4003	GUANDU LUMACHAG [QU: guandu = *Brugmansia* spp. lumachag "unknown"]	QU apply macerated LF to dogs' noses to make them better hunters1

[1]Alarcón (1988), [2]Bennett and Alarcón (unpublished field notes), [3]Bennett and Alarcón (1994)

2Author citation follows TROPICOS 2015.

Table 2. Examples of other plants given to dogs to improve their hunting abilities. Family names follow APG III (Angiosperm Phylogeny Group 2009). Species names follow The Plant List (2105). Source of data: see footnotes. For plant parts: BK=bark, FL=flower, FR=fruit, IF=inflorescence, LF=leaf, LX=latex, PL=whole plant, RH=rhizome, SD=seed, ST = stem, TU=Tuber.

Species	Family	Common Name	Location	Use
***Aframomum melegueta* K. Schum.**	Zingiberaceae	guinea pepper	Trinidad and Tobago[1]	Dried SD ground to a powder, then sprinkled on dog's food
***Anadenanthera colubrina* (Vell.) Brenan**	Fabaceae	huilca	Argentina[2]	SD snuff given to dogs to make them more more alert
***Anadenanthera peregrina* (L.) Speg.**	Fabaceae	Yopo	Colombia[2]	SD snuff given to dogs to make them more more alert
Ardisia cf. *denhamioides* S. Moore	Primulaceae	sunun	West Papua[3]	LF fed to hunting dogs to improve their performance.
***Aristolochia rugosa* Lam.**	Aristolochiaceae	mat	Trinidad and Tobago[1]	PL decocotion used to bathe lazy dogs
***Banisteriopsis caapi* (Spruce ex Griseb.) C. V. Morton**	Malpighiaceae	-	Peru[4]	See *Couroupita guianensis* [A]
***Brugmansia suaveolens* (Humb. & Bonpl. ex Willd.) Bercht. & J. Presl**	Solanaceae	-	Peru[4]	See *Couroupita guianensis* [A]
Brugmansia sp.	Solanaceae	lumu cuchi huandu	Ecuador (Quichua)[5]	See *Tabernaemontana sananho* [A]
Caladium bicolor (Ait.) Vent.	Araceae	-	Ecuador (Kofan)[13]	LF placed in dogs nostril to make them better hunters for wild pigs.
Caladium sp.	Araceae	ushu	Peru (Aguaruna)[6]	LF fed to dogs
Calliandra angustifolia Spruce ex Benth.	Fabaceae	-		See *Couroupita guianensis* [A]
Capsicum annuum L.	Solanaceae	bird pepper	Trinidad and Tobago[1]	Juice from 2 small FR placed in dog's nose

				so it find game & follow scent
Casearia negrensis Eichler	Salicaceae	ituchi runtu	Peru[4,7]	BK & Lf given to dogs to prepare them for hunting
***Cecropia peltata* L.**	Urticaceae	bois canôt	Trinidad and Tobago[1]	Dry LF is put in water with *Jatropha gossypiifolia*. Water left open for nine days until larvae are seen, then used to bathe dog.
Colocasia esculenta (L.) Schott [possibly]	Araceae	Bolobolo	Papua New Guinea[8]	Unspecified part fed to dogs to make them wild, aggressive & sensitive for hunting wild pig
***Couroupita guianensis* Aubl. [A]**	Lecythidaceae	aya uma	Peru[4]	Depurative decoction including *Banisteriopsis caapi*, *Psychotria viridis*, *P. carthagenensis, Brugmansia suaveolens*, *Calliandra angustifolia*, *Tovomita* aff. *stylosa* & *Zygia longifolia*.
***Couroupita guianensis* Aubl. [B]**	Lecythidaceae	ayahúma	Peru[9]	Unspecified part given to dogs to make them stronger & to increase their hunting abilities
Couroupita subsessilis Pilg.	Lecythidaceae	shishim	Peru (Aguaruna)[6]	BK & LF inhaled in mouth or nose to improve hunting ability
***Croton gossypiifolius* Vahl**	Euphorbiaceae	blood bush	Trinidad and Tobago[1]	Dog bathed in a LF decoction along *Petiveria alliacea* RT & *Renealmia alpinia* LF & RT if dog is not performing as well as in past
Cyperus sp.	Cyperaceae	yawaa pijipij	Peru (Aguaruna)[6]	RT fed to dogs to improve their hunting ability
Cyrtocymura scorpioides (Lam.) H. Rob.	Asteraceae	ruckshun	Trinidad and Tobago[1]	Dogs bathed with a LF decoction so that

				they will be more alert
Dendrobium pulchellum Roxb. ex Lindl.	Orchidaceae	-	Indochina[10]	FL fed to dogs to make them better hunters
Dendrobium spp	Orchidaceae	-	Solomon Islands[11]	FL, resembling dog heads, fed to hunting dogs to increase their courage in the chase
***Dendropanax arboreus* (L.) Decne. & Planch.**	Araliaceae	fei jein	Trinidad and Tobago[1,7]	Combined with LF of *Monstera dubia, Siparuna guianensis Solanum* spp. & *Syngonium podophyllum* to bathe dogs
Dracontium sp	Araceae	uchi santanik	Peru (Aguaruna)[6]	RT fed to dog to improve hunting ability
***Eschweilera subglandulosa* (Steud. ex O. Berg) Miers**	Lecythidaceae	guatacare	Trinidad and Tobago[1,7]	see *Piper marginatum*
***Jatropha curcas* L.**	Euphorbiaceae	white physic nut	Trinidad and Tobago[1]	3 LV mixed with 3 LF of *Jatropha gossypiifolia,* crushed then put in water to bathe dog
***Jatropha gossypiifolia* L.**	Euphorbiaceae	red physic nut	Trinidad and Tobago[1]	See *Jatropha curcas*
***Mansoa alliacea* (Lam.) A.H. Gentry**	Bignoniaceae	ajo sacha	Peru[4]	Stem & root BK macerated with with *Petiveria alliacea* as a body odor modifying agent for hunting & fishing
Mansoa sp.	Bignoniaceae	kaep	Peru (Aguaruna)[6]	LF, RT, BK & ST tips inhaled in mouth, nose, or fed to dogs to improve their ability to hunt

***Momordica charantia* L.**	Cucurbitaceae	caraaili	Trinidad and Tobago[1,7]	PL used to bathe dogs so that it will catch agoutis.
***Monstera dubia* (Kunth) Engl. & K. Krause**	Araceae	sei jein	Trinidad and Tobago[1,7]	See *Dendropanax arboreus*
Nectandra cuneatocordata Mez	Lauraceae	mantaga	Peru (Aguaruna)[6]	RT inhaled in mouth & nose to improve hunting ability
***Nicotiana tabacum* L. [A]**	Solanaceae	tobacco	Trinidad and Tobago[1]	LF used to cleans dog's nose to improve its ability to follow a scent
***Nicotiana tabacum* L. [B]**	Solanaceae	tobacco	South America[11]	Mixture of tobacco & *Zingiber officinale* applied to eyes to improve night vision.
***Nicotiana tabacum* L. [C]**	Solanaceae	-	Ecuador (Runa)[5]	See *Tabernaemontana sananho* [A]
***Petiveria alliacea* L.**	Phytolaccaceae	kojo root	Trinidad and Tobago[1]	Dogs bathed with ground RT to make them more alert
Phrynium sp.	Marantaceae	asin	West Papua[3]	Pieces of LF fed to hunting dogs to improve their performance
***Phyllanthus urinaria* L.**	Phyllanthaceae	-	Trinidad and Tobago[1]	FR given to bathe dogs for "cross"
***Piper hispidum* Sw.**	Piperaceae	candle bush	Trinidad and Tobago[1]	LF used to bathe dogs
***Piper marginatum* Jacq.**	Piperaceae	agouti bush	Trinidad and Tobago[1,7]	LF used to to bathe dogs so the will catch agoutis. Some hunters add *Eschweilera subglandulosa* LV.
Piper ovatum Vahl	Piperaceae	pot bush	Trinidad and Tobago1	Crushed ST & LV or RT put in dog's nose or dog's nose washed with a solution made from those parts of the plant
***Piper peltatum* L.**	Piperaceae	sun bush	Trinidad and Tobago1	Crushed LF used to bathe dog for "cross"
Piper sp. 1	Piperaceae	ampagpag	Peru (Aguaruna)[6]	RT & LF inhaled in mouth or nose or fed to dogs to improve their hunting ability

Piper sp. 2	Piperaceae	shishig	Peru (Aguaruna)[6]	LF fed to dogs to improve their hunting ability
***Pithecellobium unguis-cati* (L.) Benth.**	Fabaceae	cat's claw	Trinidad and Tobago[1,7]	Given to dogs so that they will follow game tenaciously
***Psychotria carthagenensis* Jacq**	Rubiaceae	-	Peru[4]	See *Tabernaemontana sananho* [A]
***Psychotria viridis* Ruiz & Pav.**	Rubiaceae	-	Peru[4]	See *Tabernaemontana sananho* [A]
***Renealmia alpinia* (Rottb.) Maas**	Zingiberaceae	mardi gras	Trinidad and Tobago[1,7]	5-7 shoots of are pounded & put in water to bathe dog; FR attract lice, dog will closely pursue
***Saccharum officinarum* L.**	Poaceae	sugar cane	Trinidad and Tobago[1,7]	FR & LF used to bathe dogs. Deer eat LF, therefore dog can track deer
Sarcoglottis metallica (Rolfe) Schltr.	Orchidaceae	lappe bush	Trinidad and Tobago[1,7]	PL used to bathe dog so that it will track lappe
Schuurmansia henningsii K. Schum.	Ochnaceae	sembererk	West Papua[3]	SD & LF fed to dogs to improve their performance
Siparuna guianensis Aubl.	Monimiaceae	dead man's bush	Trinidad and Tobago[1,7]	Ssee *Dendropanax arboreus*
Solanum spp.	Solanaceae	Devil pepper	Trinidad and Tobago[1,7]	Ssee *Dendropanax arboreus*
***Syngonium podophyllum* Schott**	Araceae	Matapal-kit	Trinidad and Tobago[1,7]	See *Dendropanax arboreus*
Tabernaemontana sananho Ruiz & Pav. [A]	Apocynaceae	tsita	Ecuador (Runa)[5]	Mixture given to hunting dogs so that they can communicate with their masters
Tabernaemontana sananho Ruiz & Pav. [B]	Apocynaceae	kunakip	Peru (Aguaruna)[6]	BK & RT inhaled in mouth or nose or fed to dogs dogs to improve hunting ability
Tabernaemontana sananho Ruiz & Pav. [C]	Apocynaceae	-	Ecuador (Secoya)[13]	LX from FR applied to dogs nose so that they can "smell far" in huntingatex

Tovomita aff. *stylosa* Hemsl.	Clusiaceae	-	Peru[4]	See *Couroupita guianensis* [A]
***Xanthosoma brasiliense* (Desf.) Engl.**	Araceae	hog tannia	Trinidad and Tobago[1,7]	Hogs eat tubers. Ground tuber sprinkled on dog's food so it can track hogs.
Xanthosoma undipes (K. Koch & C.D. Bouché) K. Koch	Araceae	hog tannia	Trinidad and Tobago[1,7]	See *Xanthosoma brasiliense*
***Xiphidium caeruleum* Aubl.**	Haemodoraceae	walk fast	Trinidad and Tobago[1,7]	LF given to dogs so that they will walk straight
Zingiber officinale Roscoe [A]	Zingiberaceae	ginger	South America[12]	See *Nicotiana tabacum*
Zingiber officinale Roscoe [B]	Zingiberaceae	hinde	West Papua[10]	RH & LF are fed to hunting dogs to improve their performance
Zygia longifolia (Willd.) Britton & Rose	Fabaceae	-	Peru[4]	See *Couroupita guianensis* [A]
not determined	Lamiaceae	chiujip	Peru (Aguaruna)[6]	LF fed to dogs to improve their hunting ability
not determined	Zingiberaceae	chiag	Peru (Aguaruna)[6]	LF inhaled in mouth to improve hunting ability
not determined	-	turpentine bush	Trinidad and Tobago[1]	Dogs bathed with crushed LF
not determined	-	Goma'uwe	Papua New Guinea[8]	Unspecified part fed to hunting dogs to improve their sense of smell
not determined	Acanthaceae	tsumbaik	Peru (Aguaruna)[6]	RT & LF fed to dogs to improve hunting ability
not collected	-	chijum	Peru (Aguaruna)[6]	LF fed dogs to improve hunting ability

[1]Lans et al. (2001), [2]Schultes (1998), [3]Milliken (1999), [4]Sanz-Biset et al. (2009), [5]Kohn (2007), [6]Jernigan (2009), [7]Use attributed to Doctrine of Signatures, but see Bennett (2007 & 2008) for a discussion of the doctrine, [8]Flavelle (1991), [9]McKenna et al. (1995), [10]Bennett (1995), [11]Anonymous (2009a), [12]Wilbert (1987), [13]Schultes and Raffauf (1990)

3.2 Other Cultures

The use of plants to improve the hunting ability is best documented in Ecuador and Peru but examples can be found in other South American countries as well as the Caribbean, Indochina, Papua New Guinea, and the Solomon Islands (Table 2). Examples from the literature revealed 71 citations of 65 species that are used in 54 combinations. Of these, the majority (43) are said to improve hunting ability (e.g., *Dendrobium pulchellum*). Five enhance hunting success for specific game (e.g., *Xanthosoma brasiliense* for wild hogs). Four are believed to make hunting dogs more alert (e.g., *Petiveria alliacea*) and four are said to specifically enhance olfaction. The Secoya of Ecuador apply latex from *Tabernaemontana sananho* fruits to a dog's nose so that "it can smell far." A mixture of ginger (*Zingiber officinale*) and tobacco (*Nicotiana tabacum,* Fig. 6) is thought to enhance night vision in both hunters and their dogs. Ten plants are employed in baths for hunting dogs. A mixture that includes *Tabernaemontana sananho* and *Brugmansia* sp. is given to dogs so that they "can communicate with their masters."

Figure 6. *Nicotiana tabacum* (Solanaceae) plug used by a Quichua shaman in healing ceremonies.

3.3 Plants to Improve Hunting Ability

The combined data from the Shuar and Quichua data (Table 1) and the literature (Table 2) omitting those species that are not related directly to hunting or those species that have not been determined to at least the genus, reveals 71 species in 34 families that are given to dogs to improve their hunting ability (Table 3). There is some chemical data for most of the species or from close relatives. By combining the phytochemical data with the ethnobotanical reports of plants use, we classified each species into a likely pharmacological category. Twenty six are

Table 3. Combined data from Tables 1 and 2 minus those species that have an explicitly ethnoveterinary use and are not related directly to hunting or those species that have not been determined to at least the genus. Family plus number of citations for family, species plus number of citations for genus/species). Activity column lists the probable activity in dog based on the plants use and chemistry. Chemistry column lists the compounds likely responsible for the activity.

Family	Species	Activity	Chemistry
Acanthaceae (2)	*Fittonia albivenis* (1/1)	psychoactive - hallucinogenic (?)	dimethyltryptamine (?)
	Justicia pectoralis (1/1)	psychoactive - hallucinogenic	betaine, coumarin & umbelliferone[1]; reported to have dimethyltryptamine (DMT)
Amaranthaceae (1)	*Alternanthera paronychioides* (1/1)	unknown	unknown - inhibits xanthine oxidase[2]
Apocynaceae (4)	*Tabernaemontana sananho* (1/4)	psychoactive - hallucinogenic (?)	unknown, indole alkaloids from *Tabernaemontana holstii*[3]
Aquifoliaceae (1)	*Ilex guayusa* (1/1)	psychoactive - stimulant	caffeine & other methylxanthine alkaloids[4]
Araceae (9)	*Caladium bicolor* (3/1)	olfactory sensitizer	calcium oxalate crystals[5]
	Caladium schomburgkii (3/1)	olfactory sensitizer	calcium oxalate crystals[5]
	Caladium sp. (3/1)	olfactory sensitizer	calcium oxalate crystals[5]
	Colocasia esculenta (1/1)	olfactory sensitizer	calcium oxalate crystals[5,6,7]
	Dracontium sp. (1/1)	olfactory sensitizer	calcium oxalate crystals[5,6,7]
	Monstera dubia (1/1)	olfactory sensitizer	calcium oxalate crystals[5,6,7]
	Syngonium podophyllum (1/1)	olfactory sensitizer	calcium oxalate crystals[5,6,7]
	Xanthosoma brasiliense (2/1)	olfactory sensitizer	calcium oxalate crystals[5,6,7]
	Xanthosoma undipes (2/1)	olfactory sensitizer	calcium oxalate crystals[5,6,7]
Araliaceae (1)	*Dendropanax arboreus* (1/1)	depuartive, deodorant, irritant	falcarinol, dehydrofalcarinol, undetermined diynene, falcarindiol, dehydrofalcarindiol, polyacetylenes (dendroarboreols A and B) [8,9]
Aristolochiaceae (1)	*Aristolochia rugosa* (1/1)	depuartive, anti-inflammatory, antimicrobial	aristolochic acid[10] (?)
Asteraceae (1)	*Cyrtocymura scorpioides* (1/1)	anti-tumor, vulneray	sesquiterpene lactones[11]

Bignoniaceae (2)	*Mansoa alliacea* (2/1)	depuartive, deodorant	allyl polysufides[12]
	Mansoa sp. (2/1)	depuartive, deodorant	likely similar to *Mansoa alliacea*
Clusiaceae (1)	*Tovomita* aff. *stylosa* (1/1)	depuartive, deodorant, antimicrobial	xanthones likely[13]
Cucurbitaceae (1)	*Momordica charantia* (1/1)	depuartive, deodorant, antimicrobial	momordicin, cucurbitacin b & other triterpenoid saponins[14]
Cyperaceae (2)	Cyperus sp. (2/1)	psychoactive – hallucinogenic	ergot alkaloids[15]
	Cyperus sp. (2/1)	psychoactive – hallucinogenic	ergot alkaloids[15]
Euphorbiaceae (5)	*Croton gossypiifolius* (1/1)	depuartive, deodorant, antimicrobial	essential oil dominated by oxygenated sesquiterpenes including alpha-cedrene oxide, spathulenol, valencene, geranyl-pentanoate, alpha-cadinol, germacrene d & longifolene)[17]
	Euphorbia hirta (1/1)	antimicrobial	flavonols including euphorbins, kaempferol, myricetin, quercitin & rutin[16]
	Jatropha curcas (2/1)	depuartive, deodorant, antimicrobial	hydrogen cyanide, jatrophine[18,19]
	Jatropha gossypiifolia (2/1)	depuartive, deodorant, antimicrobial	cyclic octapeptide (cyclogossine b) & cyclic heptapeptide (cyclogossine a)[20], diterpene jatrophenone[21]
	Manihot esculenta (1/1)	carrier	not applicable
Fabaceae (5)	*Anadenanthera colubrina* (2/1)	psychoactive – hallucinogenic	buforenine, n-n-dimethyltryptamine[13]
	Anadenanthera peregrina (2/1)	psychoactive - hallucinogenic	buforenine, n-n-dimethyltryptamine[13]
	Calliandra angustifolia (1/1)	psychoactive – hallucinogenic (?), stimulant	amino acids[22], reported to contain tetrahydroharmaline
	Pithecellobium unguis-cati (1/1)	psychoactive – hallucinogenic (?), stimulant	unknown
	Zygia longifolia (1/1)	depuartive, deodorant, antimicrobial (?)	volatile isoprenes, but poorly known[23]
Haemodoraceae (1)	*Xiphidium caeruleum* (1/1)	antimicrobial (?)	phenylphenalenone-type compounds[24]

Lauraceae (1)	*Nectandra cuneatocordata* (1/1)	unknown	unknown, genus contains alkaloids & terpenes[13] & lignans, neolignans, & lignoids[25,26,27]
Lecythidaceae (4)	*Couroupita guianensis* (2/3)	depuartive, deodorant, antimicrobial, antiinflammatory	tryptanthrin[28]
	Eschweilera subglandulosa (1/1)	depuartive, deodorant, antimicrobial	ellagic acid derivatives[29;] triterpenes[30]
Malpighiaceae (1)	*Banisteriopsis caapi* (1/1)	psychoactive – hallucinogenic	beta-carboline alkaloids (harmine, harmaline & tetrahydroharmine)[13,61,62]
Marantaceae (1)	*Phrynium* sp. (1/1)	unknown	unknown, rosmarinic acid, chlorogenic acid & rutin reported from family[31]
Menispermaceae (1)	*Abuta grandifolia* (1/1)	psychoactive – sedative (?)	tropoloisoquinoline[32] & bisbenzylisoquinoline[33] alkaloids
Monimiaceae (1)	*Siparuna guianensis* (1/1)	depuartive, deodorant	oxoaporphine alkaloid liriodenine, oxidized derivative of *β*-elemene-curzerenone & phenylpropanoids (myristicin & eugenol methyl ether)[34]
Myristicaceae (2)	*Osteophloeum platyspermum* (1/1)	psychoactive – hallucinogenic	unknown, presumably DMT
	Virola duckei (1/1)	psychoactive – hallucinogenic	unknown, presumably DMT
Myrsinaceae (1)	*Ardisia* cf. *denhamioides* (1/1)	Unknown	unknown - triterpenoid saponins common in the genus[35]
Ochnaceae (1)	*Schuurmansia henningsii* (1/1)	psychoactive – stimulant (?)	alkaloids[36]
Orchidaceae (3)	*Dendrobium pulchellum* (2/1)	psychoactive – hallucinogenic (?)	unknown, dendrobine & other alkaloids reported from *D. nobile*[37]
	Dendrobium spp. (1/1)	psychoactive – hallucinogenic (?)	unknown, dendrobine & other alkaloids reported from *D. nobile*[37]
	Sarcoglottis metallica (1/1)	depuartive, deodorant	unknown, flavonoids[38] & prenylated coumarins[39] found in the closely related genus *Spiranthes*
Phyllanthaceae (1)	*Phyllanthus urinaria* (1/1)	depuartive	alcohol (triacontanol), phenolic acid (gallic acid), coumarins (including ellagic acid), flavonoids (astragalin, quercetin, quercitrin, isoquercitrin, rutin, kaempfero), sterols (including β-sitosterol), triterpenes (lupeol acetate & β-amyrin)[40]
Phytolaccaceae (1)	*Petiveria alliacea* (1/1)	depuartive, deodorant	benzaldehyde, benzoic acid, coumarin, trithiolaniacine[41], cysteine

			sulfoxide derivatives[42]
Piperaceae (6)	*Piper hispidum* (6/1)	depuartive, deodorant	amide[43]; butenolides[44]; prenylated benzoic acid derivatives[45]; oxygenated sesquiterpenes & sesquiterpenes hydrocarbons including trans-nerolidol, caryophyllene oxide, beta-elemene, trans-beta-caryophyllene, curzerene, & germacrene b[46]
	Piper marginatum (6/1)	depuartive, deodorant, antimicrobial	39 components in essential oil including γ-terpinene, δ-elemene, α-copaene, β-elemene, β-caryophyllene, α-humulene, γ-elemene, 3,4-methylenedioxypropiophenone,and elemicin[47] but highly variable[48]; propiophenones[49]; flavonoids including marginatoside[50]
	Piper ovatum (6/1)	depuartive, deodorant, antimicrobial, anti-inflammatory	delta-amorphene, cis-muurola-4(14),5-diene, & gamma-muurolene51, amides (piperovatine & piperlonguminine)[52]
	Piper peltatum (6/1)	depuartive, deodorant, antimicrobial, anti-inflammatory	4-nerolidylcatechol[53,53]; aristolactams alkaloids (piperumbellactams a-d & n-hydroxyaristolam & n-p-coumaroyl tyramine[55]
	Piper sp. (6/1)	depuartive, deodorant, olfactory sensitizer	unknown
	Piper sp. (6/1)	depuartive, deodorant, olfactory sensitizer	unknown
Poaceae (1)	*Saccharum officinarum* (1/1)	depuartive, deodorant, antiinflammatory	fatty acids[56]; flavone glycosides vitexin, orientin, luteolin-8-c-(rhamnosylglucoside), 4',5'-dimethyl-luteolin-8-c-glycoside, isomeric pair schaftoside-isoschaftoside, o-glycosides tricin-7-o-neohesperidoside & tricin-7-o-glycoside[57]; flavones (tricin-7-o-beta-(6''-methoxycinnamic)-glucoside & orientin[58]; flavones (apigenin, luteolin & tricin derivatives), phenolic acids (hydroxycinnamic, caffeic & sinapic acids)[59]
Rubiaceae (2)	*Psychotria carthagenensis* (2/1)	psychoactive – hallucinogenic	DMT commonly reported[14] but not found in one study[60]; triterpene (beta-sitosterol & ursolic acid)[61]
	Psychotria viridis (2/1)	psychoactive – hallucinogenic	DMT[62,63] but variable

Salicaceae (1)	*Casearia negrensis* (1/1)	unknown	unknown, clerodane diterpenoids[64] reported for genus
Solanaceae (11)	*Brugmansia* × *insignis* (6/1)	psychoactive – hallucinogenic	tropane alkaloids (atropine & scopolamine)[14]
	Brugmansia sp. (6/1)	psychoactive – hallucinogenic	tropane alkaloids (atropine & scopolamine)[14]
	Brugmansia suaveolens (6/2)	psychoactive – hallucinogenic	tropane alkaloids (atropine & scopolamine)[14]
	Brugmansia versicolor (6/1)	psychoactive – hallucinogenic	tropane alkaloids (atropine & scopolamine)[14]
	Brugmansia sp. (6/1)	psychoactive – hallucinogenic	tropane alkaloids (atropine & scopolamine)[14]
	Capsicum annuum L. (1/1)	olfactory sensitizer	capsiacins[14,65]
	Nicotiana tabacum (3/3)	psychoactive – stimulant, MAO inhibitor, ophthalmic	nicotine[14,66]
	Solanum spp. (1/1)	depuartive	Unknown
Urticaceae (1)	*Cecropia peltata* (1/1)	depuartive	chlorogenic acid & isoorientin[67]
Zingiberaceae (4)	*Aframomum melegueta* (1/1)	depuartive, antimicrobial	CYP inhibitor[68]; 27 compounds sesquiterpene hydrocarbons (humulene & caryophyllene & their oxides) 17 monoterpenes [69]
	Renealmia alpinia (1/1)	depuartive, antimicrobial	labdane diterpenoids[70]; triacylglycerols (including oleic, palmitic & palmitoleic acids), sterols, methylsterols & triterpenic alcohols[71]; monoterpenes (b-pinene, limonene & b-phellandrene), b-carotene, nerolidol & manool, labdadiene-15,16-dial (i) [71]
	Zingiber officinale (2/2)	ophthalmic	phenols (gingerols & shogaols), volatile oils (sesquiterpenes - β-bisabolene, (–)-zingiberene, β-sesquiphellandrene, & (+)-ar-curcumene; monoterpenes - geranial & neral)[73]

[1]Macrae & Towers (1984), [2]Chen et al. (2009), [3]Kingston et al. (2006), [4]Lewis et al. (1991), [5]Oscarsson & Savage (2007), [6]Savage et al. (2008), [7]Prychid & Rudall (1999), [8]Bernart et al. (1999), [9]Hansen & Boll (1986), [10]Heinrich et al. (2009), [11]Buskuhl et al. (2010), [12]Zoghbi et al. (2009), [13]Schultes & Raffauf (1990), [14]Fatope et al. (1990), [15]Plowman et al. (1990), [16]Kumar et al. (2010), [17]Suárez et al. (2011), [18]Duke (1993), [19]Thomas et al. (2008), [20]Auvin-Guette et al. (1997), [21]Ravindranath, et al. (2003), [22]McKenna et al. (1995), [23]Geron et al. (2002), [24]Opitz & Schneider (2002), [25]Carvalho et al. (1986), [26]Moro et al. (1986), [27]Barbosa-Filho et al. (1989), [28]Pinheiro et al. (2010), [29]Yang et al. (1998), [30]Costa & Carvalho (2003), [31]Abdullah et al. (2008), [32]Menachery & Cava (1980), [33]Steele et al. (1999), [34]Leitão et al. (1999), [35]Liu et al. (2011), [36]Pelletier (1996), [37]Southon & Buckingham (1989), [38]Donget al. (2008), [39]Peng et al. (2008), [40]Calixto et al. (1998), [41]Anonymous (2009b), [42]Kubec & Musah (2001), [43]Alécio et al (1998), [44]Michel et al. (2010), [45]Friedrich et al. (2005), [46]Pino et al. (2009), [47]Ramos et al. (1986), [48]Andrade et al. (2008), [49]de Diaz & Gottlieb (1979), [50]Tillequin et al. (1978), [51]Silva et al. (2009), [52]Rodrigues et al. (2008),

[53]Kijjoa et al. (1980), [54]Núñez et al. (2005), [55]Tabopda et al. (2008), [56]Ledón et al. (2003), [57]Colombo et al. (2006), [58]Duarte-Almeida et al. (2007), [59]Duarte-Almeida et al. (2006), [60]Leal & Elisabetsky (1996), [61]Lopes et al. (2000), [62]Pires et al. (2009), [63]Callaway et al. (2005), [64]Chen et al. (2008), [65]Cichewicz & Thorpe (1996), [66]Wilbert (1987), [67]Andrade-Cetto & Cárdenas Váz (2010), [68]Agbonon et al. (2010), [69]Ajaiyeoba & Ekundayo (1999), [70]Zhou et al. (1997), [71]Lognay et al. (1989), [72]Lognay et al. (1991), [73]Blumenthal et al. (2000)

depuratives/deodorants (e.g., *Siparuna guianensis*), and many of these also have antimicrobial or anti-inflammatory activity. Ten species are classified as olfactory sensitizers Araceae (e.g., *Caladium schomburgkii*). The largest category was psychoactives, with 25 species. Nineteen of these species are hallucinogens (e.g., *Banisteriopsis caapi*, Fig. 7) and most of the remaining are stimulants (e.g., *Ilex guayusa*). Two are opthalmic (discussed previously). The remaining are either unknown or difficult to classify.

Figure 7. *Banisteriopsis caapi* (Malpighiaceae), known as natem in the Shuar and ayahusca in the Runa languages, split stems.

3.3.1 Depuratives/Deodorants

More than half of the depuratives/deodorants have noticeably strong odors (Table 4). *Dendropanax arboreus* has a distinctive odor due to the presence of polyactetylenes. The specific epithets of *Mansoa alliacea* and *Petiveria alliacea*, together with some of their common names, refer to the plants' garlic-like odor. *Siparuna* and *Piper* spp. possess abundant volatile terpenoids compounds that contribute to their strong and distinctive aromas. Cucurbitacins found in *Momordica charantia* produce its characteristic and pungent smell. Sesquiterpenes and monoterpenes in *Renealmia alpinia* and *Zingiber officinale* contribute to the distinctive ginger aroma of these plants.

Table 4. Species, arranged by family, that are used as depuratives or deodorants.

Family	Species
Araliaceae	*Dendropanax arboreus*
Aristolochiaceae	*Aristolochia rugosa*

Bignoniaceae	*Mansoa alliacea*
	Mansoa sp.
Clusiaceae	*Tovomita* aff. *stylosa*
Cucurbitaceae	*Momordica charantia*
	Croton gossypiifolius
	Jatropha gossypiifolia
Fabaceae	*Zygia longifolia*
Lecythidaceae	*Couroupita guianensis*
	Eschweilera subglandulosa
Monimiaceae	*Siparuna guianensis*
Orchidaceae	*Sarcoglottis metallica*
Phyllanthaceae	*Phyllanthus urinaria*
Phytolaccaceae	*Petiveria alliacea*
Piperaceae	*Piper hispidum*
	Piper marginatum
	Piper ovatum
	Piper peltatum
	Piper sp.
	Piper sp.
Poaceae	*Saccharum officinarum*
	Solanum spp.
Urticaceae	*Cecropia peltata*
Zingiberaceae	*Aframomum melegueta*
	Renealmia alpinia

3.3.2 Olfactory Sensitizers

The olfactory sensitizers are dominated by the Araceae (Table 5). This family is characterized by the presence of irritating calcium oxalate crystals. Two other plants were

classified in this category *Capsicum annuum* with irritating capsaicins and a *Piper* sp. with unknown chemical components. In addition to applying *Capsicum annuum* around the eyes of their hunting dogs to enhance vision, the Quichua believe that this practice protects the animals from evil spirits.

Table 5. Species, arranged by family, that are used as olfactory sensitizers.

Family	Species
Araceae	*Caladium bicolor*
	Caladium schomburgkii
	Caladium sp.
	Colocasia esculenta
	Dracontium sp.
	Monstera dubia
	Syngonium podophyllum
	Xanthosoma brasiliense
	Xanthosoma undipes
Piperaceae	*Piper* sp.
Solanaceae	*Capsicum annuum* L.

3.3.3 Psychoactives

The psychoactive plants given to dogs are dominated by hallucinogens (Table 6). While most of these are well-known as hallucinogenic plants and are commonly used in shamanistic rituals (e.g., *Anadenanthera peregrina, Banisteriopsis caapi*) the activity of others is yet to be determined (e.g., *Fittonia albivenis, Dendrobium pulchellum*). The stimulants *Ilex guayusa* (caffeine & other methylxanthine alkaloids) and *Nicotiana tabacum* also are given to hunting

dogs. Quichua heat tabacco leaves, then administer them through the noses of their dogs to keep them active and resilient during the hunting trips.

Table 6. Species, arranged by family, that have probable psychoactive effects.

Family	Species
Acanthaceae	*Fittonia albivenis*
	Justicia pectoralis
Apocynaceae	*Tabernaemontana sananho*
Aquifoliaceae	*Ilex guayusa*
Cyperaceae	*Cyperus* sp.
Fabaceae	*Anadenanthera colubrina*
	Anadenanthera peregrina
	Calliandra angustifolia
	Pithecellobium unguis-cati
Malpighiaceae	*Banisteriopsis caapi*
Menispermaceae	*Abuta grandifolia*
Myristicaceae	*Osteophloeum platyspermum*
	Virola duckei
Ochnaceae	*Schuurmansia henningsii*
Orchidaceae	*Dendrobium pulchellum*
	Dendrobium spp.
Rubiaceae	*Psychotria carthagenensis*
	Psychotria viridis
Solanaceae	*Brugmansia* × *insignis*
	Brugmansia suaveolens
	Brugmansia versicolor

Brugmansia sp.
Nicotiana tabacum

4. Discussion

Hunting dogs are indispensable to many traditional cultures. The relationship between these animals and humans is far deeper that in modern cultures. This is evident by both the beliefs regarding dogs and by the ethnoveterinary pharmacopoeias devoted to dogs. Under the influence of the hallucinogenic beverage natem (*Banisteriopsis caapi*), one Shuar shaman sees the commonly-reported vision of boas and jaguars, but also dogs (Bennett et al. 2002). The Quichua believe that dogs have souls and that they dream (Kohn 2007).

The ethnopharmacopoeia for dogs has recently received greater attention from researchers (e.g., Bennett et al. 2002; Lans et al 2000, 2001; Leonard et al. 2002; Jernigan 2009). Yet relatively few studies have examined practices that are said to improve hunting abilities. Koster (2009) summarizes non-pharmacological practices to enhance hunting abilities, which include exposing dogs to the flesh or hair of prey before hunting trips and covering a dog with blood from killed prey, rubbing it with stomach contents, or giving it meat from prey animals. Quichua feed agouti bile or its sternum to their dogs so that they can find this prized game species.

Relatively little attention has been given to plants that are said to improve hunting efficiencies in dogs. Yet their use is widespread. Among the Matsigenka of Peru, hunting ability is believed to be acquired only by the use of plants that enhance a hunter's visual acuity, sense of smell, aim, stamina and luck (Shepard 2002). One quarter of Matsigenka medicinal plant

species are used as hunting medicines and these include plants given to hunting dogs to increase olfactory sensitivity.

The effects of psychoactive substances in humans to other animals is not always comparable. Not surprisingly, nonhuman primates provide are most similar in their responses (Weerts et al. 2007). Dogs respond to commonly-used hallucinogens in a similar manner to humans. Vaupel et al. (1978a) showed that beta-phenethylamine and d-amphetamine increased respiration, dilated pupils and produced restlessness in chronically spinalized dogs. Frith et al. 1987 recorded circling, dilated pupils, hyperactivity, rapid breathing, and salivation in dogs given methylenedioxymethamphetamine. These effects potentially could enhance a dog's hunting ability. Scopolamine significantly impaired memory performance of old, but not young dogs (Araujo et al. 2011). Young hunting dogs seem to be preferred by lowland Amazonian people. For many of the plant compounds, pharmacological studies on dogs is lacking. Nonetheless, based on descriptions of the plants uses, their effects on humans, and their phytochemical profiles, one can speculate on their pharmacological effects in canines.

4.1 Ophthalmics

Only two species were cited as nocturnal ophthalmics – agents that improve vision. Wilbert (1987) reported that a mixture of tobacco and ginger is applied to the eyes of both hunters and their dogs to improve night vision. Few studies have examined the effects of plant extracts on night vision. Tetrahydrocannabinol from *Cannabis sativa* L. has been shown to enhance night visions in some studies (e.g., Russo et al. 2004). The effects of tobacco are less clear. While some studies have shown that tobacco smoke decreases night vision, others have

shown that nicotine enhances night vision, presumably due to the stimulating effects of nicotine (Anonymous 2011). There are no studies on the effects of ginger on night vision. Though the atropine containing genus *Brugmansia* was one of the more frequently cited psychoactive plants given to hunting dogs, the reason for its use was never explicitly said to be related to improvement of vision. Atropine is well-known as a mydriatic and homatropine has been shown to improve nocturnal myopia (Koomen et al. 1951).

4.2 Depuratives/Deodorants

Depuratives/deodorants plants remove or mask odors and improve the ability of hunting dogs to avoid detection by game. Most of them also possess antimicrobial activity that could prevent the development of characteristic odors associated with infections. Shephard (1999) offers an alternate reason for the use of the sulfurous odor of *Mansoa* among the Matsigenka of Peru. They believe that the plant's odor is similar to the smell of peccaries, a preferred Matsigenka game animal.

Other reasons for the use of depuratives/deodorants that transcend the physical effects of moderating odors. The exceedingly fragrant *Siparuna* and *Piper* spp., which are used to bathe dogs, are also employed by the Quichua to cleanse the human body of malevolent spirits. This practice is concordant with their belief that dogs possess souls.

4.3 Olfactory Sensitizers

Little is known about the mechanism of action of Araceae species on olfaction. Most members of the family contain irritating calcium oxalate crystals (Prychid and Rudall 1999).

Another irritant that is employed to enhance olfaction is *Capsicum annuum*. Frasnelli et al. (2009) showed that capsaicins can enhance olfaction in humans and perhaps the same activity is true for canines. Another plant that was said to enhance olfaction was *Tabernaemontana sananho*. Latex from the fruits or leaves are applied to a dog's nose so that "it can smell far." Based on the chemistry of the genus it is likely that, the activity targeting the brain rather than directly affecting the nose. In addition to Jernigan's (2009) study, Brown (1981) reported the use of *Tabernaemontana sananho* for dogs among the Aguaruna and Vickers and Plowman (1984) noted similar use among the Secoya of Ecuador.

4.4. Psychoactives

The use of psychoactive plants given to improve the hunting abilities of dogs is counter-intuitive. Both the Shuar and Quichua give *Ilex guayusa*, which contains methylxanthines, to their hunting dogs. The methylxanthine alkaloid theobromine is toxic to dogs (Strachan and Bennet, 1994). Small doses of the related alkaloid caffeine generate benign arrhythmias in dogs; higher doses cause severe arrhythmias (Mehta et al. 1997). There is clearly a dose-dependent response in canines. Small doses may induce alertness in habituated animals. Quichua deliver small nasal doses to their dogs.

The use of psychoactive hallucinogenic preparations is even more beguiling. The use of hallucinogenic plants in hunting medicines is widespread, but best developed in Ecuador and Peru. All the major Shuar hallucinogens, with the exception of *Brunfelsia grandifolia* also are given to hunting dogs. These hallucinogens contain serotonin agonists (ergot-like alkaloids from *Cyperus* sp.; N-N, dimethyltryptamine from *Virola* and *Pyschotria*), monoamine oxidase

inhibitors (β-carboline alkaloids from *Banisteriopsis caapi*), and anticholinergics (scopolamine and atropine from *Brugmansia* spp.) (McKenna et al. 1998, Perry and Perry 1995, Shen et al. 2010).

Serotonin agonists can induce hallucinations in both humans and animals (Wink 2000). Scopolamine hallucinations result from antagonism of ACh receptors (Palfai and Jankiewicz 1997) and the ensuing hallucinations usually often are visual (Perry and Perry, 1995). A common cerebral anticholinergic effect includes bizarre and aggressive behavior (Palfai and Jankiewicz 1997). Acetylcholine plays a key role in sustained attention in both serial reaction time and signal detection tasks. The muscarinic cholinergic antagonist scopolamine substantially impairs accuracy of subjects in the tests (Levin et al. 2011). Aghajanian and Marek (1999) argue that the effects of hallucinogens on glutamatergic transmission in the cerebral cortex may be responsible for higher-level cognitive, perceptual, and affective distortions.

4.4.1 Pharmacology

How then can hallucinogens enhance hunting? Much of the psychopharmacological literature suggests that they are more likely to impair ability. Yet, some evidence is supportive. The mode of action of psilocybin, another serotonin agonist, includes thalamic down-regulation and frontal hypermetabolism, which may contribute to drug-induced synesthesia (Stevenson and Tomiczek, 2007). Synesthesia refers to the stimulation of one sensory or cognitive pathway leads to automatic, involuntary experiences in a second sensory or cognitive pathway. This

process may be responsible not only for hallucinations but also for the enhanced olfactory, auditory or visual senses in hunting dogs.

4.4.2 Case Studies

Other evidence comes from case studies of humans under the influence of hallucinogens. Pedro Kunkumas, a Shuar shaman, said that under the influence of natem (*Banisteriopsis caapi* and *Diplopterys cabrerana* (Cuatrec.) B. Gates) beverages, the body of his patient appears like an x-ray. He can then locate tsentsaks, magical arrows that cause illness, and thus diagnose the patient. Another shaman said that he could hear voices from a long distance under after drinking natem (Bennett et al. 2002). After taking LSD for the first time, two college associates of one of the authors, awoke simultaneously. Both were delirious, believing they were about to be run over by a tractor-trailer. Several hours later they recovered and said that it sounded as if the truck was nearly on top of them. Turning on the lights contributed to their hallucination. Under normal condition, the sound of a trucks downshifting or upshifting on a nearby grade was barely audible. LSD appeared to enhance auditory perception just as natem enhances perceptions in shamans.

Jernigan (2009) reports that the Aguaruna give plants (*Brugmansia* sp., *Mansoa* sp., and *Tabernaemontana sananho*) to their dogs because they produce visions of the intended prey. The Shuar believe that *Brugmansia* spp. help dogs obtain supernatural power (Bennett et al. 2002). For the Quichua described by Kohn (2009), the hallucinogenic mixture tsicta (which includes *Tabernaemontana sananho*, *Nicotiana tabacum*, and *Brugmansia* sp.) is given to dogs so that they can communicate with their masters and to counsel them.

5. Conclusions

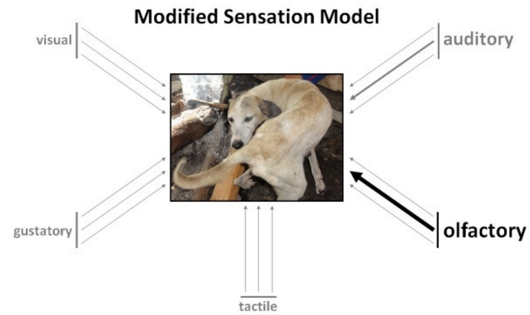

Figure 8. Modified Sensation Model. In normal circumstances, arrows representing sensory input would be of the same magnitude. Under the influence of psychoactive plant extracts, we hypothesize that non-hunting related sensations are blocked, while those related to hunting are enhanced. In tropical rainforests this is most likely to be olfaction.

Why give psychoactive plants to hunting dogs? The pharmacological literature suggests equivocal effects of hallucinogens on perception. Moreover, data on the effects of psychoactive plants on dogs is limited deriving mostly from the use of dogs as laboratory surrogates for humans. No studies have investigated the effects of traditional preparations on hunting dogs and the possibility that they can somehow enhance perception that affects the ability to tracking of game animals. Nonetheless, the practice of administering psychoactive plants to canines is well-established. Could such a practice persist if it impaired hunting success? This is unlikely as hunting is a crucial complement to subsistence practices in the lowland tropics. Vollenweider (1994) hypothesized a disruptive effect of activity of psychedelic substances on sensory gating–the filtering of redundant or superfluous stimuli. Riba et al. (2002), in contrast, suggest ayahuasca has a P50 suppressing effect on sensory gating in humans. We hypothesize that hallucinogenic plants alter perception in hunting dogs by diminishing ancillary signals and enhancing others that aid in the detection and capture of game (Fig. 8). If this is true, the implications are significant. Perhaps plant substance could enhance the ability of dogs to detect explosives, drugs, human remains, or enhance the scores of other abilities for which dogs are valued.

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